PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Hideyuki Kurita et al.

Group Art Unit: 2841

Application No.: 09/640,862

Examiner: I. Patel

Filed: August 18, 2000

Docket No.: 107082

For: PROCESSES FOR MANUFACTURING FLEXIBLE WIRING BOARD AND THE RESULTING FLEXIBLE WIRING BOARDS

AMENDMENT UNDER 37 C.F.R. §1.111

Director of the U.S. Patent and Trademark Office
Washington, D.C. 20231

Sir:

In reply to the Office Action mailed September 13, 2001, the period for reply being extended by the attached Petition for Extension of Time, please amend the above-identified application as follows:

IN THE DRAWINGS:

Please correct Figures 2, 3 and 5 in accordance with the attached Request for Approval of Drawing Corrections.

IN THE ABSTRACT:

Please replace the Abstract filed with the substitute Abstract attached hereto.

IN THE SPECIFICATION:

Page 8, lines 5-10, delete current paragraph and insert therefor:

FIG. 2 (a) - (d) is a processing diagram showing a process for manufacturing a flexible wiring board according to the present invention (middle steps).

A1 FIG. 3 (a) - (d) is a flow sheet showing a process for manufacturing a flexible wiring board according to the present invention (late steps).

Page 8, lines 14-16, delete current paragraph and insert therefor:

FIG. 5 (a) - (c) is a flow sheet showing a process for manufacturing a flexible wiring board having a multilayer structure according to the present invention (the second half).

A2

Page 9, lines 21-25, delete current paragraph and insert therefor:

Separately from the second metal film 11, a first metal film 12 consisting of a rolled copper foil having a thickness of 9 μm - 35 μm is prepared (Fig. 2(a)), and a polyimide precursor solution is applied on its surface and heat-treated to form a first resin film 16 consisting of a polyimide film (Fig. 2(b)).

A3

Page 10, lines 11-17, delete current paragraph and insert therefor:

Then, the bumps 21 on the second metal film 11 treated as above are faced to the first resin film 16 on the first metal film 12 as shown in Fig. 2(c) and hot-pressed to force the bumps 21 into the first resin film 16.

A4

Fig. 2(d) shows that the bumps 21 have been forced into the resin film 16 so that they are in contact with the first metal film 12 underlying the first resin film 16.

Page 10, line 24 - page 11, line 8, delete current paragraph and insert therefor:

Then, a patterned resist layer is formed on the top surface of the first metal film 12 and etched to pattern the first metal film 12. After etching, the resist layer is removed to give a flexible wiring board 3 having the patterned first metal film 12 (Fig. 3(a)). The reference number 35 in Fig. 3(a) represents an opening formed removal zone of the patterned first metal film 12. The opening 35 is a zone dividing wiring from each other. The first resin film 16 is exposed at the bottom of the opening 35. However, the first resin film 16 is not exposed at the bottom surface of the first resin film 16 on the side of the second metal film 11.

A5

Page 12, lines 19-24, delete current paragraph and insert therefor:

This state is shown in Fig. 3(b), in which the tip 54 of the resonator 52 is pressed against the flexible wiring board 3 by the air cylinder 53 so that the tops of the bumps 21 are strongly pressed against the first metal film 12 because the first resin film 16 is softer than the first and second metal films 12, 11 and the bumps 21.

A6

Page 13, lines 8-13, delete current paragraph and insert therefor:

The flexible wiring board 3 is removed from the ultrasonic bonding apparatus 50 and a patterned resist layer is formed on the top surface of the second metal film 11, which is then etched. After etching, the resist layer is removed. The reference number 36 in Fig. 3(c) represents an opening formed in the patterned second metal film 11.

A7

Page 14, lines 6-13, delete current paragraph and insert therefor:

Fig 4(a) shows a flexible wiring board 4 having the first and second metal films 12, 11 exposed on the top surface and the bottom surface of the first resin film 16. (This flexible wiring board 4 is the flexible wiring board 4 shown in Fig. 3(c).) A polyimide precursor solution is applied on the top surface of the flexible wiring board 4 and heat-treated to form a second resin film 18 consisting of a polyimide film shown by the reference number 18 in Fig. 4(b). This second resin film 18 has not been imidated.

A8

Page 15, lines 10-21, delete current paragraph and insert therefor:

Then, the flexible wiring board 6 in this state is mounted on the working table 58 in the ultrasonic bonding apparatus 50 shown in Fig. 6 and brought into contact with the tip 54 of the resonator 52. When the ultrasonic wave is applied, the bumps 22 ultrasonically vibrate and are ultrasonically bonded to the first metal film 12 in contact with them. After ultrasonic bonding, the flexible wiring board removed from the ultrasonic bonding apparatus 50 has a multilayer structure shown by the reference number 7 in Fig. 5(b).

A9

A polyimide precursor may be applied on this flexible wiring board 7 to form a resin film, which may be further layered on a metal film having bumps and imidated. In this case, the steps shown in Fig. 4(b) - (e) and Fig. 5(a) are repeated.

IN THE CLAIMS:

Please replace claim 14 as follows:

14. (Amended) A flexible wiring board comprising a plurality of patterned metal films with a resin film being interposed therebetween among which adjacent two patterned metal films are electrically connected to each other via bumps, wherein said resin film is cured after said bumps are pressed against the top surface of said resin film, and forced into said resin film to electrically connected said two patterned metal films via said bumps.

REMARKS

Claims 1-17 are pending. By this Amendment, the specification and abstract are amended, Figs. 2, 3 and 5 are corrected by the attached Request for Approval of Drawing Corrections, and claim 14 is amended.

The attached Appendix includes marked-up copies of each rewritten paragraph (37 C.F.R. §1.121(b)(1)(iii)) and claim (37 C.F.R. §1.121(c)(1)(ii)).

Applicants affirm the election of Group II, claims 14-17 with traverse.

I. THE DRAWINGS SATISFY ALL FORMAL REQUIREMENTS

The Office Action objects to Figs. 2, 3 and 5. Figs. 2, 3 and 5 are corrected in accordance with the attached Request for Approval of Drawing Corrections.

II. THE SPECIFICATION SATISFIES ALL FORMAL REQUIREMENTS

The Office Action objects to the abstract. The abstract is amended to obviate this objection. Furthermore, the specification is amended in accordance with the corrected drawings.

III. CLAIMS 14 AND 15 DEFINE PATENTABLE SUBJECT MATTER

The Office Action rejects claims 14-17 under 35 U.S.C. §103(a) over U.S. Patent No. 5,600,103 to Odaira et al. This rejection is respectively traversed.

In the invention of claim 14, the organic solvent is evaporated from the curing resin film partially exposed between the patterned metal film because the resin film is cured in the manner that the metal film is patterned. See, e.g., page 10, line 24-page 11, line 18.

Odaira does not disclose that resin film disposed between the metal films is cured in the manner that the metal films are patterned.

In Odaira, organic solvents remain in the cured resin film. The organic solvent can not be evaporated into the atmosphere, when the resin film having metal film not patterned is heated to be cured.

IV. CONCLUSION

In view of the foregoing, Applicants respectfully submit that this application is in condition for allowance. Favorable consideration and prompt allowance are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is requested to contact the Applicants' undersigned representative at the telephone number listed below.

Respectfully submitted,

James A. Oliff
Registration No. 27,075

Michael Britton
Registration No. 47,260

JAO:MB/rrs

Attachments:
Appendix
Petition for Extension of Time
Substitute Abstract
Request for Approval of Drawing Corrections

Date: February 13, 2002

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Alexandria, Virginia 22320
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DEPOSIT ACCOUNT USE AUTHORIZATION
Please grant any extension necessary for entry;
Charge any fee due to our Deposit Account No. 15-0461

ABSTRACT OF THE DISCLOSURE

Against a first resin film formed on a first metal film are pressed bumps on a second metal film so that the bumps are embedded into the first resin film. Either one of the first metal film or the second metal film or both is (are) patterned while the bumps are in contact with the first metal film, and the first resin film is heat-treated while the top of the first resin film is partially exposed to discharge the solvent or moisture from the exposed zone and cure the first resin film. After curing, the bumps and the first metal film may be ultrasonically bonded to each other. A second resin film and a third metal film may be further layered to form a multilayer structure.

APPENDIX

Changes to Abstract:

The following is a marked-up version of the amended Abstract:

~~The present invention aims to connect metal films without forming any opening in a resin film.~~

~~———~~Against a first resin film ~~16~~ formed on a first metal film ~~12~~ are pressed bumps ~~21~~ on a second metal film ~~11~~ so that the bumps ~~21~~ are embedded into the first resin film ~~16~~. Either one of the first metal film ~~12~~ or the second metal film ~~11~~ or both is (are) patterned while the bumps ~~21~~ are in contact with the first metal film ~~12~~, and the first resin film ~~16~~ is heat-treated while the top of the first resin film is partially exposed to discharge the solvent or moisture from the exposed zone and cure the first resin film ~~16~~. After curing, the bumps ~~21~~ and the first metal film ~~12~~ may be ultrasonically bonded to each other. A second resin film and a third metal film may be further layered to form a multilayer structure.

Changes to Specification:

Page 8, lines 5-10:

FIG. 2 (~~f~~a) - (~~i~~d) is a processing diagram showing a process for manufacturing a flexible wiring board according to the present invention (middle steps).

FIG. 3 (~~j~~a) - (~~m~~d) is a flow sheet showing a process for manufacturing a flexible wiring board according to the present invention (late steps).

Page 8, lines 14-16:

FIG. 5 (~~f~~a) - (~~h~~c) is a flow sheet showing a process for manufacturing a flexible wiring board having a multilayer structure according to the present invention (the second half).

Page 9, lines 21-25:

Separately from the second metal film 11, a first metal film 12 consisting of a rolled copper foil having a thickness of 9 μm - 35 μm is prepared (Fig. 2(~~f~~a)), and a polyimide precursor solution is applied on its surface and heat-treated to form a first resin film 16 consisting of a polyimide film (Fig. 2(~~g~~b)).

Page 10, lines 11-17:

Then, the bumps 21 on the second metal film 11 treated as above are faced to the first resin film 16 on the first metal film 12 as shown in Fig. 2(~~h~~c) and hot-pressed to force the bumps 21 into the first resin film 16.

Fig. 2(~~i~~d) shows that the bumps 21 have been forced into the resin film 16 so that they are in contact with the first metal film 12 underlying the first resin film 16.

Page 10, line 24 - page 11, line 8:

Then, a patterned resist layer is formed on the top surface of the first metal film 12 and etched to pattern the first metal film 12. After etching, the resist layer is removed to give a flexible wiring board 3 having the patterned first metal film 12 (Fig. 3(~~j~~a)). The reference number 35 in Fig. 3(~~j~~a) represents ~~a~~an opening formed removal zone of the patterned first metal film 12. The opening 35 is a zone dividing wiring from each other. The first resin film 16 is exposed at the bottom of the opening 35. However, the first resin film 16 is not exposed at the bottom surface of the first resin film 16 on the side of the second metal film 11.

Page 12, lines 19-24:

This state is shown in Fig. 3(~~k~~b), in which the tip 54 of the resonator 52 is pressed against the flexible wiring board 3 by the air cylinder 53 so that the tops of the bumps 21 are strongly pressed against the first metal film 12 because the first resin film 16 is softer than the first and second metal films 12, 11 and the bumps 21.

Page 13, lines 8-13:

The flexible wiring board 3 is removed from the ultrasonic bonding apparatus 50 and a patterned resist layer is formed on the top surface of the second metal film 11, which is then etched. After etching, the resist layer is removed. The reference number 36 in Fig. 3(~~l~~c) represents an opening formed in the patterned second metal film 11.

Page 14, lines 6-13:

Fig 4(a) shows a flexible wiring board 4 having the first and second metal films 12, 11 exposed on the top surface and the bottom surface of the first resin film 16. (This flexible wiring board 4 is the flexible wiring board 4 shown in Fig. 3(~~l~~c).) A polyimide precursor solution is applied on the top surface of the flexible wiring board 4 and heat-treated to form a second resin film 18 consisting of a polyimide film shown by the reference number 18 in Fig. 4(b). This second resin film 18 has not been imidated.

Page 15, lines 10-21:

Then, the flexible wiring board 6 in this state is mounted on the working table 58 in the ultrasonic bonding apparatus 50 shown in Fig. 6 and brought into contact with the tip 54 of the resonator 52. When the ultrasonic wave is applied, the bumps 22 ultrasonically vibrate and are ultrasonically bonded to the first metal film 12 in contact with them. After ultrasonic bonding, the flexible wiring board removed from the ultrasonic bonding apparatus 50 has a multilayer structure shown by the reference number 7 in Fig. 5(~~g~~b).

A polyimide precursor may be applied on this flexible wiring board 7 to form a resin film, which may be further layered on a metal film having bumps and imidated. In this case, the steps shown in Fig. 4(b) - (e) and Fig. 5(~~f~~a) are repeated.

Changes to Claims:

The following is a marked-up version of the amended claim:

14. (Amended) A flexible wiring board comprising a plurality of patterned metal films with a resin film being interposed therebetween among which adjacent two patterned metal films are electrically connected to each other via bumps, wherein said resin film is cured after said bumps are pressed against the top surface of said resin film, and forced into said resin film to electrically connected said two patterned metal films via said bumps.